Middle School Science DCAS review:

**Nature of Science**

Scientists were testing a new medicine (called Pavil) to see if it was able to cure headaches.

They gave three people with headaches a dose of Pavil. They gave three other people a pill that looked like Pavil but had no active ingredients. The three people who took Pavil reported that their headaches disappeared after 20 minutes. The three who took the other pill reported that their headaches were no better two hours later. As a result of this work, Pavil was approved by the United States Food and Drug Administration as the cure for headaches.

Based on this experiment, why was the Food and Drug Administration’s decision to approve Pavil as a cure for headaches inappropriate?

1. The experiment shows that Pavil may not be able to cure all kinds of headaches.
2. The experiment used a sample size that was too small to make this decision.
3. The experiment did not follow the scientific method.
4. The experiment did not test the effect of Pavil on people who did not have headaches.

Choose the correct response.

Explain your answer below:

Correct answer: b

This question tests Standard 1, Nature and Application of Science and Technology

1.1.2. Understand that: A valid investigation controls variables. Different experimental designs and strategies can be developed to answer the same question.

Be able to: Design and conduct investigations with controlled variables to test hypotheses. **(E)**

1.1.3. Understand that: In a scientific investigation, data collection involves making precise measurements and keeping accurate records so that others can replicate the experiment.

Be able to: Accurately collect data through the selection and use of tools and techniques appropriate to the investigation. **(E)**

1.1.4. Understand that: There is much experimental and observational evidence that supports a large body of knowledge. The scientific community supports known information until new experimental evidence arises that does not match existing explanations. This leads to the evolution of the scientific body of knowledge.

Be able to: Form explanations based on accurate and logical analysis of evidence. Revise the explanation using alternative descriptions, predictions, models and knowledge from other sources as well as results of further investigation. **(E)**

Explanation:

The conclusion from statement a may be true, but this experiment does not compare the effect of Pavil on different types of headaches.

Statement c is incorrect because the scientific method is not helpful in this experiment.

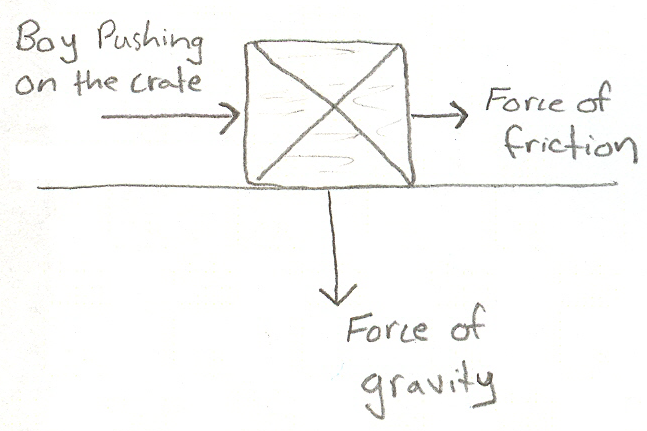
Statement d is not relevant to this experiment. The only variable being tested is the effect of Pavil vs. a placebo on relieving headaches.

**Balanced and Unbalanced Forces**



A boy is pushing a large crate across the floor at constant speed. Identify all of the forces acting on the crate and then draw a force diagram. Remember that a good force diagram shows the approximate sizes and directions of all of the forces that are acting on the crate.

A student provides the following force diagram in his response:



The student’s force diagram is incorrect because

1. The force of gravity acts in the opposite direction of the crate’s motion.
2. There is a force of the box pushing on the boy.
3. The force of friction must be larger than the force of the boy pushing on the crate.
4. The force of friction should be in the opposite direction of the force of motion.

Explain your answer:

There is a missing force from this diagram. Which is it? (directions of force are shown with arrow)

1. The supporting force of the floor which is equal to the force of gravity.
2. The force of air resistance which is equal to the force of friction.
3. The force of heat on the box which is smaller than the force of friction.
4. The electric force which is greater than the force of the boy pushing.

Explain your answer

Answer: First question: Answer: d

Second question: Answer a

This question tests Standard 3, Energy and its Effects

3.2.1. When the forces acting on an object are balanced, its motion will not change. Unbalanced forces will cause the object’s motion to change. Changes in motion depend upon the size and direction of the total unbalanced force exerted on the object. **(E)**

Explanation:

First question: The force of gravity is correct as drawn. The second choice is a correct statement (students are not expected to know this) but doesn’t answer the question. The third choice would result in the box not moving in the direction indicated.

Second question: Choice b: air resistance may be an indicated force, but it would not balance the force of friction. Choice c: heat is not a force, it is a type of energy. Choice d: not relevant or correct.

**Gravitational Potential Energy/Kinetic Energy**

You and your friends have started to play a new game called Tiki Ball. Tiki Ball is very much like bowling, with one exception.

6 meters

The ball in Tiki Ball is released down a ramp without being pushed. The ball must roll six meters on the ground before it strikes any pins (the pins are called “tikis.”). The player adjusts the height and the direction of the ramp to bring down the ten tikis..

The player may choose to use a ramp of any length desired. The only two rules are that the ball must roll six meters before striking a tiki, and the ball must not be pushed—it can only move by rolling down the ramp on its own.

The three diagrams shown below show three possible ways the ball can be played in Tiki Ball. Assume that all three ramps are made of the same material, and assume that the ball does not bounce when it reaches the ground.

A. Ramp length = 15 meters ramp height = 5 meters

B. Ramp length = 15 meters ramp height = 10 meters

C. Ramp length = 20 meters ramp height = 5 meters

(NOTE: not all Tikis are visible in the following diagrams)

**A.**

ramp length = 15 meters

ramp height = 5 meters

6 meters

**B.**

ramp length = 15 meters

ramp height = 10 meters

6 meters

**C.**

ramp length = 20 meters

ramp height = 5 meters

6 meters

1. After playing Tiki Ball many times, you realize that the ball doesn’t always have enough energy to knock down all the tikis.

Which of the following diagrams (A, B, or C) will have the greatest chance of knocking down all the tikis.

1. Diagram a
2. Diagram b
3. Diagram c
4. All three diagrams have the same chance of knocking down all the tikis.

Explain your answer in terms of potential and kinetic energy.

1. When you and one of your friends played Tiki Ball last week, you used a hollow golf ball (usually you use a solid golf ball, which knocks down most of the tikis.). The hollow golf ball was released in the set-up shown in figure A. The hollow ball stopped rolling before it reached the first tiki. Why did the hollow ball not roll as far as the solid ball?
2. The hollow ball was made of a completely different material, so it would be expected to move more slowly.
3. The hollow ball is more delicate than the solid ball, so pieces of it break of while rolling.
4. The hollow ball has a smaller mass, so it has less kinetic energy when it hits the tikis.
5. The hollow ball has the same kinetic energy as the solid golf ball, but that energy is lost.

Explain your answer.

Answers: Question 1: b

Explanation: The number of tikis knocked down depends on the ball’s kinetic energy. The KE at the bottom will depend on the GPE at the top. The GPE depends on the height of the ball, not the length of the ramp.

Question 2: c

The two factors that affect the ball’s GPE are its height and its mass. The hollow ball has a smaller mass, so it will have less GPE (therefore less KE) than the solid ball. Choice a may be true, but a different material may also make the ball move more quickly. Nothing in the question suggests that the ball is broken while rolling (therefore b is wrong). Choice d states that energy is lost—energy is never lost.

Standards:

3.1.1 Energy can be transformed from one form into another. Energy transformations often take place while energy is being transferred to another object or substance. Energy transformations and energy transfers can be used to explain how energy flows through a physical system (e.g., photosynthesis, weathering, electrical circuits). **(E)**

**Particle Model**

Below are three diagrams of the particles that make up a common substance. One of them is a solid, one is a liquid, one is a gas. However, the diagrams are not in that order:

**A B**

**C**

Which statement is true?

1. Box B contains a liquid because the particles are closest together.
2. Box A contains a gas, and the particles are moving very quickly.
3. Box C contains a solid, because it has the fewest particles.
4. Box B contains a solid, but the diagram is incorrect, because the particles should be larger.

Explain your answer.

Correct response: b

Explanation: Response a gives a correct explanation, but the box contains a solid. Response c is incorrect and the explanation is incorrect. Response d gives a correct answer, but the statement about the size of the particles is incorrect.

Standard 2, Materials and their Properties

All matter consists of particles too small to be seen with the naked eye. The arrangement, motion, and interaction of these particles determine the three states of matter (solid, liquid, and gas). Particles in all three states are in constant motion. In the solid state, tightly packed particles have a limited range of motion. In the liquid state, particles are loosely packed and move past each other. In the gaseous state, particles are free to move. **(E)**

A cube of ice with a mass of 18.6 grams and a coin with a mass of 5 grams are together in a sealed container. The next day the ice is

melted. What is the mass of the materials in the container?

1. Five grams, because the mass of the water is too small to measure.
2. Less than 18.6 grams. The mass of water is lower than the mass of ice.
3. 23.6 grams. It is the mass of the ice plus the mass of the coin.
4. There is no way to determine. The mass of the water is not related to the mass of the ice.

Answer: c

Explanation: Since the container is sealed, the mass does not increase or decrease, even though the materials in the cup change state.

Standard:

* + 1. A phase change may occur when a material absorbs or releases heat energy. Changes in phase do not change the particles but do change how they are arranged. **(I)**
    2. Some physical properties, such as mass and volume, depend upon the amount of material. Other physical properties, such as density and melting point, are independent of the quantity of material. Density and melting point are unique physical properties for a material. Tools such as microscopes, scales, beakers, graduated cylinders, Celsius thermometers, and metric rulers are used to measure physical properties. **(E)**

You have been handed four coins that (you are told) are foreign coins made of gold. Which of the following will determine if this statement is true?

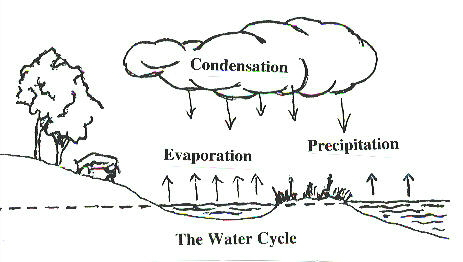
1. The mass of each is the same as the mass of a gold nugget: 43 grams.
2. The volume of each is the same as the volume of a gold nugget: 2.23 ml.
3. The density of each is the same as the density of a gold nugget: 19.3 g/ml.
4. The surface temperature of each is the same as the surface temperature of a gold nugget: 25 º C

Correct answer: c . Density is the only intrinsic property listed. Explanation would indicate that the density of gold is the same no matter what form it is.

Standard: Some physical properties, such as mass and volume, depend upon the amount of material. Other physical properties, such as density and melting point, are independent of the quantity of material. Density and melting point are unique physical properties for a material. . **(E)**

**Water Cycle**

Below is a picture from an elementary science textbook that illustrates the movement of water.



Which of the following statements correctly describes an energy transformation that occurs?

1. Condensation inside the cloud involves gaseous water particles decreasing in energy and becoming a liquid.
2. Precipitation involves the liquid particles in the water increasing in energy and becoming a gas.
3. Evaporation involves the solid particles in the water increasing in energy and becoming a liquid.
4. Condensation in the cloud involves the liquid particles in the water decreasing in energy and becoming a gas.

Explain your answer

Correct answer: a

Explanation: Choice b is incorrect because precipitation does not involve a phase change. Evaporation does involve particles increasing in energy, but they become a gas. Choice d is incorrect because decreasing energy causes the phase to change from gas to liquid (note, a common misconception is that clouds are made of water vapor, a gas, rather than water droplets or ice crystals).

Standards:

Energy and its effects:

* + 1. The addition or removal of heat energy from a material changes its temperature or its physical state. **(I)**

Earth’s Dynamic Systems:

5.1.1. Water exists on the Earth in reservoirs (on or within the Earth’s surface and atmosphere). The total amount of water in these reservoirs does not change, however, the ratio of water in solid, liquid, or gaseous form varies over time and location. **(E)**

5.2.1. Water cycles from one reservoir to another through the processes of evaporation, transpiration, condensation and precipitation. Energy transfers and/or transformations are associated with each of these processes. **(E)**

**Genetics**

**Lady Spike**

**Jake Glory Rascal Belle**

?

**Sassy Patch Dot Mo Spot Lassie**

This pedigree shows a family of fictional organisms that have either plain or spotted noses. Glory, Belle and Spot have spotted noses.

Are spotted noses the result of a dominant or recessive gene? How do you know?

1. Dominant, because they appear in every generation after they appear once.
2. Recessive, because although Lady and Spike do not have spotted noses, their offspring do.
3. Recessive, because the trait appears more often in females than in males.
4. Dominant, because only one parent has to have the trait for it to be expressed.

Correct response: b.

Response a is not always true and there is insufficient evidence to back this up. Response c is a common misconception in genetics. The pedigree does not support the statement offered in Response d.

Standard: Diversity and Continuity in Living Things

* + 1. Alternative versions of genes (different alleles) account for variations in inherited characteristics (i.e., flower color). Pairs of chromosomes that have the same allele present on both chromosomes are homozygous. Pairs of chromosomes with different alleles are heterozygous. **(E)**

7.1.10. A dominant trait will be expressed if the organism is heterozygous or homozygous for the trait. A recessive trait will only be expressed if the organism is homozygous for the trait. **(E)**

**What is the chance that Lassie has a spotted nose? Use a Punnett** **square to help answer your question.**

**This item measures student’s understanding that sexually reproduced offspring get one half of their genetic information from one parent and one half from the other and that patterns of inheritance follow rules and are therefore predictable.**

Criteria for a correct response (**2**)

:

1. Lassie has a fifty percent chance of getting a spotted nose.
2. Punnett Square needs to be completed correctly.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S = plain | s = spots |  |  |  |
|  |  |  |  |  |
|  |  | Rascal |  |  |
|  |  |  |  |  |
| Belle |  | S | s |  |
|  | s | Ss | ss |  |
|  | s | Ss | ss |  |

Criteria for a partial response (**1**):

Punnett square is correct but it is interpreted incorrectly (i.e. Lassie has a different % chance) **or**

Percentage is correct but Punnett Square is incorrect or missing.

Criteria for an incorrect response (**0**):

Percentage is incorrect **and** Punnett Square is incorrect or missing.

Standard: 7.1.11. Mendelian genetics can be used to predict genotypes and phenotypes of offspring resulting from sexual reproduction. **(E)**

**Both species below live in a small puddle and share the same food source.**

Species A Species B

**The pond floods and the food source is carried away to another part of the pond. Which species would be more capable of surviving several generations?**

1. Species A, because there are more organisms.
2. Species B, because these organisms each have a different food source.
3. Species B, because their different appearances suggests they have greater genetic diversity.
4. Species A, because their common genetic makeup provides resistance to environmental stress.

Explain your answer

Correct response: c

Explanation: Response a is incorrect—numbers of organisms will not affect survival of several generations. Response b contradicts the stem of the question. Response d is contrary to the standard.

Standard:

* + 1. Some organisms reproduce sexually involving two parents. Sexual reproduction results in offspring that have greater genetic diversity than those resulting from asexual reproduction. One-half of the offspring’s genetic information comes from the “male” parent and one-half comes from the “female” parent. These genetic differences help to ensure the survival of offspring in varied environments. **(E)**

**Characteristics of Living things and the Cell**

Although a burning candle is not a living thing, it shares some characteristics with living things. Which of the following characteristics does a burning candle share with living things?

1. Both reproduce.
2. Both experience a phase change.
3. Both transform and transfer energy.
4. Both are made of cells.

Explain your response

Correct response: c

A candle does not reproduce, and a candle is not made of cells. A living thing does not experience a phase change.

Standard: Life Processes:

6.1.1 Living organisms share common characteristics that distinguish them from non-living, dead, and dormant things. They grow, consume nutrients, exchange gases, respond to stimuli, reproduce, need water, eliminate waste, and are composed of cell(s). **(E)**

**Movement of air—Weather.**



1. It is a summer day at this beach. Look at the air movement shown by the arrows in the diagram. Why does the air move in this direction?
2. Air over the water is warmer and less dense, so it rises.
3. The sailboat pushes air from the water to the land.
4. Air on the land is absorbed by the palm trees so it rises.
5. Air on the land heats faster than air over the water, so it is less dense and rises.

Correct response: d

Response a contradicts what the arrows indicate. Responses b and c suggest that the items in the environment exert a major effect on the movement of air.

Standard: Earth’s Dynamic Systems

5.2.7. The climate at a location on Earth is the result of several interacting variables such as latitude, altitude and/or proximity to water. **(E)**

5.2.8. Energy from the Sun heats the Earth unevenly causing pressure differences and air movements (convection currents) resulting in changing weather patterns. **(E)**

**Energy Transfer and Transformation—waves**

1. Which statement is true of waves?
   1. Waves transport energy over great distances without transporting matter.
   2. All waves transport energy at the same speed.
   3. The mass of a wave is related to the amount of energy it carries.
   4. Waves can only travel where there are particles present.

Explain your answer:

1. A hockey puck is hit along the ice. Assuming it does not bump into anything and can move in a straight line, it will eventually stop. What happens to the energy of movement in the puck?
   1. The energy of the puck is transferred to the particles in the air and in the ice.
   2. The energy of the puck is used up and gone.
   3. The energy of the puck is transferred through the stick to the player to increase her speed.
   4. The energy of the puck stays with the puck.

Correct answers: 1 a

Explanation: Response b is incorrect. The speed of waves are affected by the medium through which they move. Response c makes no sense because a wave has no mass. Response d does not include electromagnetic waves.

2: a Response b is a common misconception. Response c may occur but will not affect the player’s speed. Response d is incorrect—energy is transferred to something.

Standards: Energy and its Effect

3.2.4 When energy from the sun is transferred to objects and substances, it can be transformed into a variety of energy forms. **(E)**

3.3.1. Energy can be transformed from one form into another. Energy transformations often take place while energy is being transferred to another object or substance. Energy transformations and energy transfers can be used to explain how energy flows through a physical system (e.g., photosynthesis, weathering, electrical circuits). **(E)**

**Earth in Space**

In Wilmington, DE, the average high temperature in July (summer) is 84 º F. Six months later in January (winter) the average high temperature is 38 º F.

Explain this difference in temperatures using information about the Earth’s revolution around the sun and position in space.

**This item measures the student’s understanding of the combined effects of the Earth’s tilt and the Earth’s position around the sun on the temperature differences during the seasons.**

Criteria for a complete response (**2**):

1. Student states that the Earth’s axis is tilted.

2. Student points out that because of the tilt, in the summer, Wilmington is pointed toward the sun and therefore the sun’s rays are more direct than they are in the winter, when Wilmington is pointed away from the sun.

Criteria for a partial response (**1**):

Student refers to the tilt of Earth’s axis, but does not refer to the directness of the sun’s rays during the year **or**

Student mentions that the sun’s rays are more direct during the summer than during the winter, but does not relate this difference to the tilt of the Earth.

Criteria for an incorrect response (**0**):

Student refers to the Earth’s tilt, but states that the tilt changes during the year **or**

Student states that the difference in temperature is because the Earth is closer to the sun in the summer than in the winter.

Standards: 4.1.2. The tilt of Earth’s axis of rotation as it orbits the Sun points in the same direction with respect to the stars. The tilt and the orbital motion of Earth around the Sun cause variation in the amount of solar radiation striking a location on the Earth’s surface which results in variation in the length of day/night and seasons. **(E)**

The moon goes through several phases in one month. One half of the Moon is always illuminated. What causes the phases of the moon?

a. The earth’s gravity causes the lit part of the moon to be unbalanced at various times of the month.

b. The sun’s rays reflect off the Earth (mostly the oceans and the polar icecaps). The phases of the moon are the result of how the light bounces off the Earth.

c. The moon revolves around the Earth, showing the same side to the Earth. The phases occur because this side is not always pointed directly at the sun.

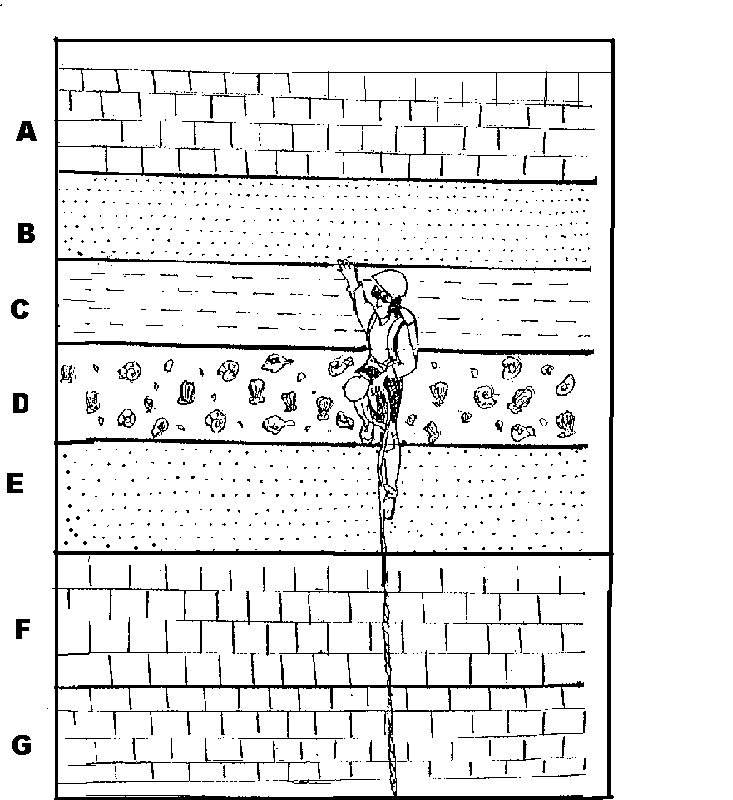
d. The Earth’s atmosphere distorts the moon’s light, making it appear as a crescent or a full moon at various times.

Correct response: c

Standard: 4.1.3 Moon phases occur because the relative positions of Earth, Moon, and Sun change, thereby enabling us to see different amounts of the Moon’s surface. **(I)**

**Earth History**

A mountain climber on the Colorado Plateau is climbing up a cliff. On the way up, he notices seashell fossils in rock layer D.



Why is layer D not on the top surface?

a. Layer D has eroded away, giving rise to the other layers.

b. Layer D formed after Layers A, B, and C.

c. Layer D formed from volcanic activity

d. Layer D formed before the layers on top of it. Layers C, B, and A were deposited in that order.

Correct response: d

Standards:

5.1.3 The formation of sediment and soil requires a long period of time as rocks are weathered, eroded and deposited. (I)

**Ecosystems**



1. Name one factor that might have explained the change in the population from 1935 to 1940.

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1. Identify one structure on the deer that gives it an advantage for survival. Describe how this structure is an advantage.

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Draw a complete food web of a woodland/agricultural area of Delaware with at least 6 organisms, including the white-tailed deer. **Remember to use arrows to show the source of and flow of energy through the system.**

Rubrics:

Name one factor that might have explained the change in the population from 1935 to 1940.

Criteria for a complete response (**2**):

Student provides a plausible reason for the decline.

Criteria for an incorrect response (**0**):

Student identifies an increase or no change in the population **or**

Student does not identify a pattern and gives an inadequate explanation for a decline.

Identify one structure on the deer that gives it an advantage for survival. Describe how this structure is an advantage.

Criteria for a complete response (**2**):

1. Student identifies a structure that gives the deer an advantage for survival.
2. Student describes why the structure is advantageous.

Criteria for a partial response (**1**):

Student identifies a structure, and lists an adaptation for survival, but the adaptation does not relate to the structure **or**

Student identifies a structure but not why the structure is advantageous **or**

Student identifies an adaptation (e.g. camouflage, keen sense of smell) but does not name a structure that confers that adaptation.

Criteria for an incorrect response (**0**):

Student identifies an essential characteristic instead of an adaptation (e.g. fur is a characteristic. Brown fur is an adaptation because it can provide camouflage in the woods) **or**

Student identifies behaviors instead of a structure

Draw a complete food web of a woodland/agricultural area of Delaware with at least 6 organisms, including the white-tailed deer. **Remember to use arrows to show the source of and flow of energy through the system.**

Criteria for a complete response (2):

1. Student uses arrows to show the flow of energy from the sun through the ecosystem.

2. Student identifies 6 organisms that constitute a web that includes producers, consumers, and decomposers found in a woodland and/or agricultural area of Delaware.

**\*Teacher notes – diagram should show a web, not several food chains. Bears, wolves, mountain lions are acceptable consumers. Erroneous student work indicates that some ignore the role of the sun and decomposers in the food web.**

Criteria for a partial response (1):

Shows a food chain, including the sun, instead of a web, but the flow of energy is accurate and decomposers are included **or** shows web, including the sun, but omits decomposers and energy flow is accurate **or** shows a web, including the sun, but has 5 organisms and energy flow is accurate.

Criteria for an incorrect response (0):

Shows web but does not have the correct flow of energy, i.e. the arrows are reversed or omitted **or** omits the sun as the source of energy **or** includes organisms not found in woodland/agriculture areas in Delaware such as elephants, tigers or monkeys **or** includes the sun but has fewer than 5 organisms in the web.

Standards:

8.1.5. The size of populations may change as a result of the interrelationships among organisms. These may include predator/prey ratios, availability of resources, and habitat changes. **(E)**

7.2.6. The great variety of body forms and structures found in difference species enable organisms to survive in diverse environments. **(E)**

8.2.3. All organisms, including humans, are part of and depend on food webs. Food webs recycle matter continuously as organisms are decomposed after death to return food materials to the environment where it re-enters a food web. **(I)**